RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

SMOOTH-WATER LANDING STABILITY AND ROUGH-WATER LANDING AND TAKE-OFF BEHAVIOR OF A $\frac{1}{13}$-SCALE MODEL OF THE CONSOLIDATED VULTEE SKATE 7 SEAPLANE

TED NO. NACA DE 338

By Robert F. McKann, Claude W. Coffee,
and Donald D. Arabian

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Langley Air Force Base, Va.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

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SUMMARY

A model of the Consolidated Vultee Aircraft Corporation Skate 7 seaplane was tested in Langley tank no. 2. Presented without discussion in this paper are landing stability in smooth water, maximum normal accelerations occurring during rough-water landings, and take-off behavior in waves.

INTRODUCTION

The Consolidated Vultee Aircraft Corporation has proposed a jet-propelled type of seaplane (called the "Skate") in which the hull bottom is merged into the wing which results in an over-all depth of airplane much less than that used in conventional flying boats. Models of several different configurations of the Skate type seaplane have been tested by Consolidated Vultee by using their open-water hydrodynamic test facilities.

At the request of the Bureau of Aeronautics, Department of the Navy, a general evaluation of the hydrodynamic characteristics of the Skate 7 is being conducted in Langley tank no. 2.

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The take-off stability characteristics of a $\frac{1}{13}$-scale model of the Skate 7 were presented in reference 1 and the resistance and spray characteristics in reference 2. The results obtained from the investigation of smooth-water and rough-water landings and rough-water taxying tests are given in the present paper.

MODEL AND APPARATUS

The $\frac{1}{13}$-scale powered model used in these tests was designed and constructed by the Consolidated Vultee Aircraft Corporation. Photographs of the model, designated Langley tank model 261, are shown in figure 1. Photographs of the model on the monorail launching gear and the fore-and-aft gear are shown in figures 2 and 3. The general arrangement and hull lines are shown in figures 4 and 5. Pertinent dimensions are given in table I. The design of the hull is discussed in references 3 and 4.

Smooth-water landings were made from the monorail launching gear. Rough-water landings were made with the use of a launching gear attached to the rear of the towing carriage. The normal accelerations were measured by single-component time-history accelerometers mounted near the center of gravity.

The rough-water take-offs were made with the use of a fore-and-aft gear attached to the towing carriage. The model had approximately 4 feet of fore-and-aft freedom with respect to the towing carriage in order to absorb the longitudinal accelerations induced by impacts. Jet thrust was simulated by supplying air from a reservoir on the towing carriage to the ejectors mounted one in each throat of the twin jets. An inductance-type accelerometer mounted on the towing staff of the model measured the vertical accelerations. Slide-wire pickups were used to measure the trim and rise of the model. A recording oscillograph was used to record time histories of the model motions.

Waves were generated by a wavemaker located at the north end of the tank. The motions of a plate hinged at the bottom of the tank and driven by a connecting arm at the top of the plate generated approximately trochoidal waves that traveled through the test section and were dissipated by a beach at the other end of the tank. The desired height and length of waves were obtained through selection of the proper amplitude and frequency of oscillation of the plate.

PROCEDURE

Landing Stability

Smooth water.- The gross weight of the model corresponded to 33,370 pounds, full size, for these tests. The center of gravity was located at 20 percent mean aerodynamic chord, and the flaps were deflected 20° for the landing tests. The model was catapulted into the air as a free body at various landing attitudes and glided onto the water in simulation of power-off landings. The motions of the model were noted by visual observations and recorded by motion-picture cameras.

Rough water.- The landing gross weight corresponding to 29,170 pounds, full size, (Navy specification SS1C2) could not be met with the addition of the accelerometer and launching brackets; therefore, for these tests, the model gross weight corresponded to 33,370 pounds, full size.

Prior to landing, the model was placed on the towing-carriage launching gear at a landing attitude of 8° with flaps deflected 20° and with the center of gravity at 20 percent mean aerodynamic chord. The towing carriage was held at a constant speed, slightly above model flying speed, and the model was released from the launching gear and glided onto the oncoming waves in simulation of an actual landing. As for the smooth-water tests, the motions of the model were noted from visual observation and motion-picture records.

Take-Off Stability

Rough water.- The model gross weight during rough-water take-offs corresponded to 40,050 pounds, full size, inasmuch as it was impracticable to meet the design gross weight with the addition of the towing fittings.

The take-off behavior in rough water was investigated with full power, fixed elevator deflections, and flaps deflected 20° at a forward rate of acceleration of approximately 5.5 feet per second per second.

RESULTS

All the data as presented are converted to full-scale values. In the static condition, both accelerometers used were considered to be at zero impact reading; thus, the data presented do not include the acceleration of gravity. The maximum normal accelerations in smooth water with the step vent duct open and closed are plotted against contact trim in figure 6. Typical time-history plots of the normal accelerations are shown in figure 7. The number of skips, maximum amplitudes of oscillation in trim, and the maximum amplitude of vertical motion at the center of gravity with the step vent duct open and closed are plotted against contact trim in figure 8. A skip was defined as an oscillation in rise during which the point of the step leaves the water. The skipping that occurred during the high-trim landings with the step vent duct open was apparently upper-limit porpoising. The beneficial effect of step ventilation was most noticeable for the low-trim landings.

The variation of maximum normal accelerations with wave length is shown in figure 9. The maximum normal acceleration of approximately 7g occurred at a wave length of approximately 220 feet. Typical time histories of the normal accelerations in various wave lengths are shown in figure 10.

Time histories from a typical oscillograph record made during rough-water take-offs are shown in figure 11. The model tended to follow the motions of the waves during the early part of the take-off. The oscillations in trim became great as speed was increased but did not exceed the stall trim for the model. Negative accelerations are not plotted as the trace of these accelerations on the oscillograph records was too faint to be read.

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REFERENCES

1. McKann, Robert E., Coffee, Claude W., and Arabian, Donald D.: Take-Off Stability Characteristics of a $\frac{1}{13}$-Scale Model of the Consolidated Vultee Skate 7 Seaplane - TED No. NACA DE 338. NACA RM SL9D28a, Bur. Aero., 1949.

2. McKann, Robert E., Coffee, Claude W., and Arabian, Donald D.: Resistance and Spray Characteristics of a $\frac{1}{13}$-Scale Model of the Consolidated Vultee Skate 7 Seaplane - TED No. NACA DE 338. NACA RM SL9G21, Bur. Aero., 1949.

3. Caldwell, R. W.: Data and Specifications for a $\frac{1}{13}$ Scale Powered Tank Model of Skate 7. Rep. No. ZH-063, Consolidated Vultee Aircraft Corp., Jan. 20, 1949.

4. Caldwell, R. W.: Hydrodynamic Design of the Consolidated Vultee Seaplane Night Fighter. Rep. No. ZH-061, Consolidated Vultee Aircraft Corp., Dec. 1948.

TABLE I

GENERAL DATA FOR THE CONSOLIDATED VULTEE SKATE 7 SEAPLANE -

LANGLEY TANK MODEL 261

	Full size	Model
Hull:		
Gross load, lb	33,000	[a]14.88
Length of forebody to step point, in.	495	38.06
Length of afterbody, in.	345	26.55
Length over all, in.	984	75.7
Beam between spray strips, in.	109	8.39
Depth of step, in.	8.4	0.646
Deadrise angle at step, deg	30	30
Sternpost angle, deg	6.74	6.74
Afterbody keel angle, deg	5.5	5.5
Height of center of gravity above base line in.	58	4.46
Height of center line of jet inlet above base line, in.	78.12	6.01
Wing:		
Area, sq ft	960	5.69
Span, in.	744	57.2
Root chord, in.	266	20.4
Tip chord, in.	106	8.15
Mean aerodynamic chord, $\bar{c}$, in.	197.8	15.2
Leading edge of mean aerodynamic chord aft of bow, in.	387.5	29.8
Aspect ratio	4.0	4.0
Sweep of 25-percent chord line, deg	35	35
Horizontal tail:		
Total area projected, sq ft	144	0.85
Span, in.	288	22.15
Dihedral, deg	10	10
Vertical tail:		
Total area, sq ft	117	0.69
Power:		
Static thrust, lb	15,000	6.84

[a]Specific weight of Langley tank no. 2 water in these tests was 63.2 lb/cu ft.

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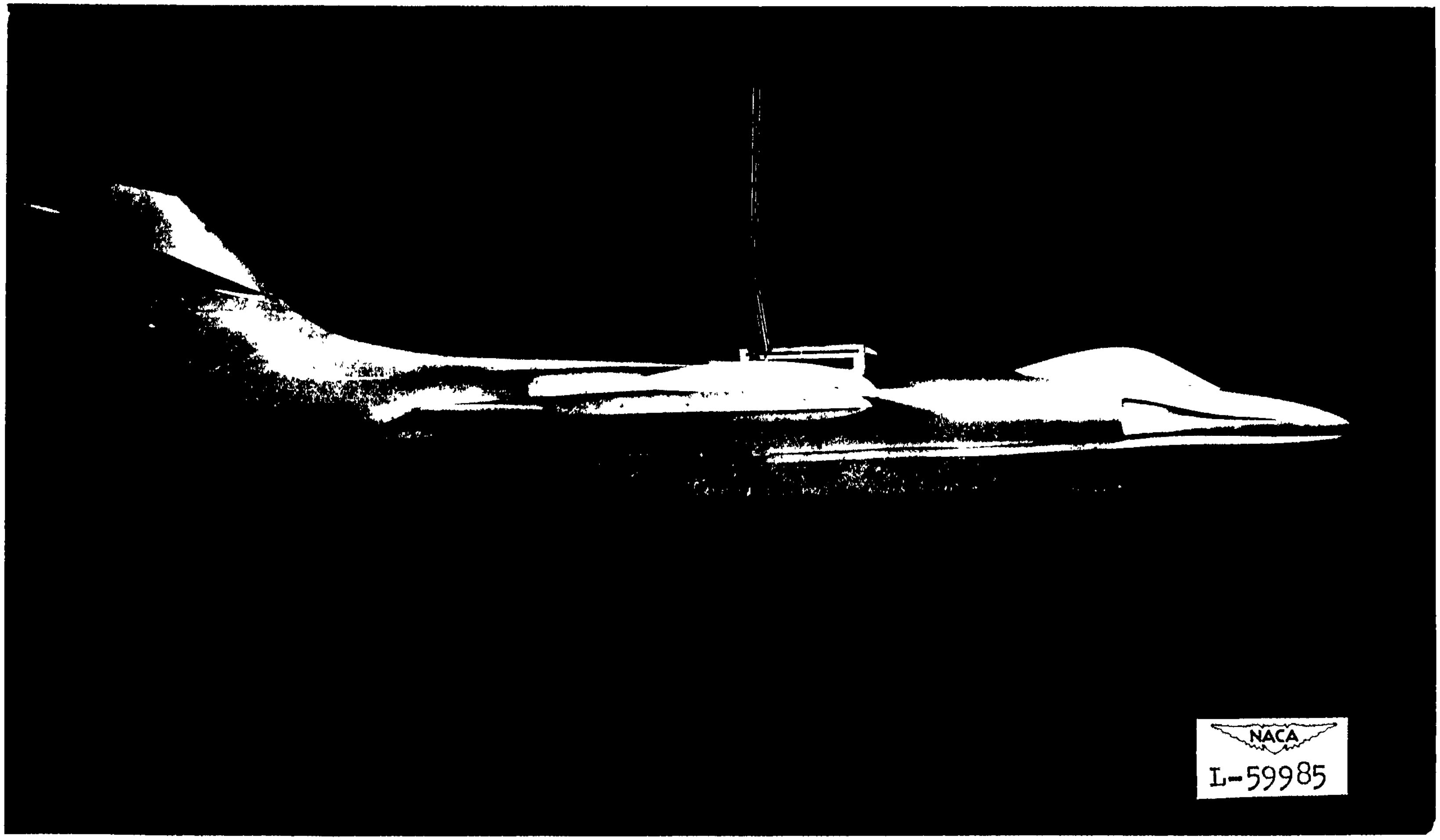

(a) Profile view.

Figure 1.- Langley tank model 261.

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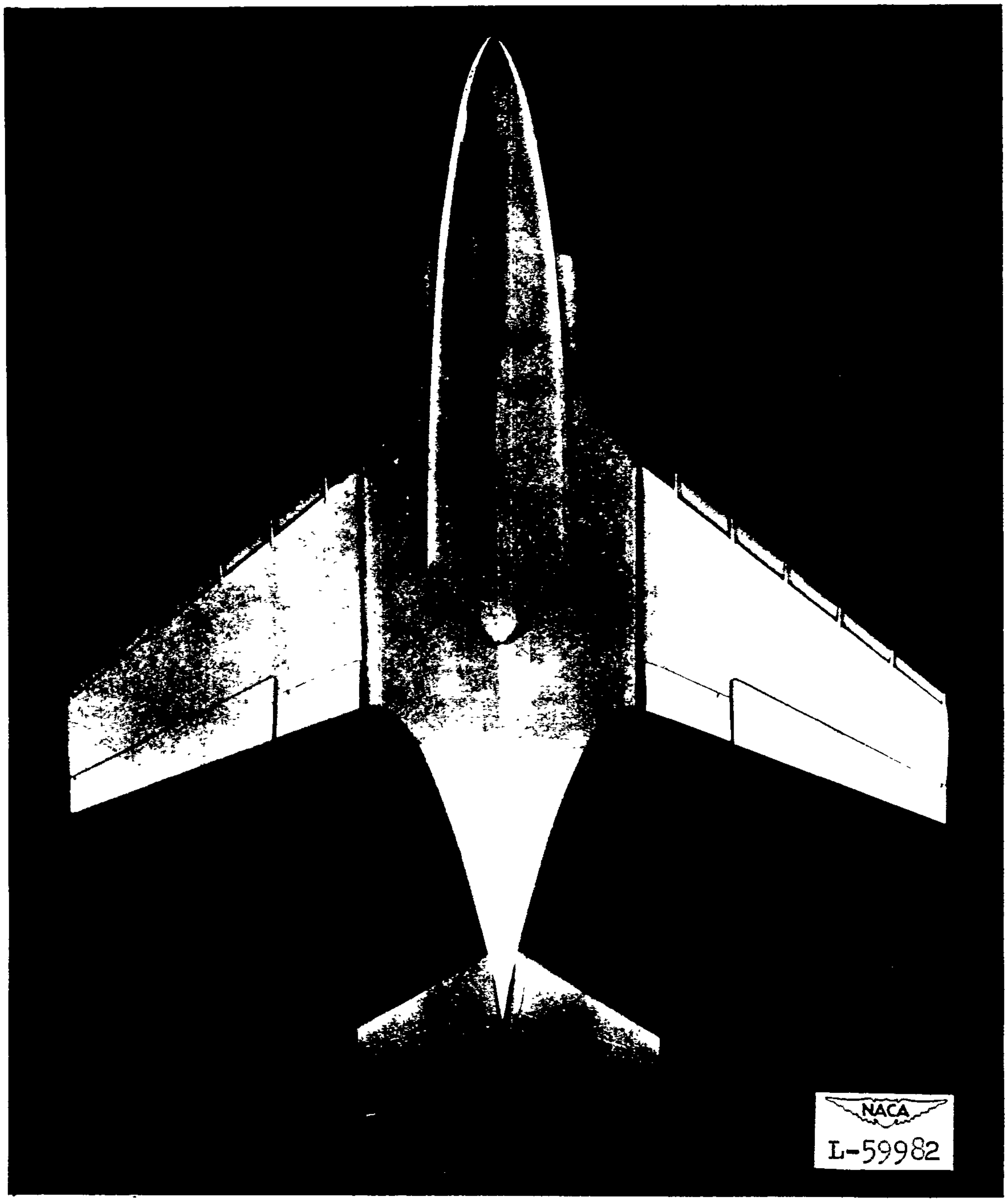

(b) Bottom view.

Figure 1.— Concluded.

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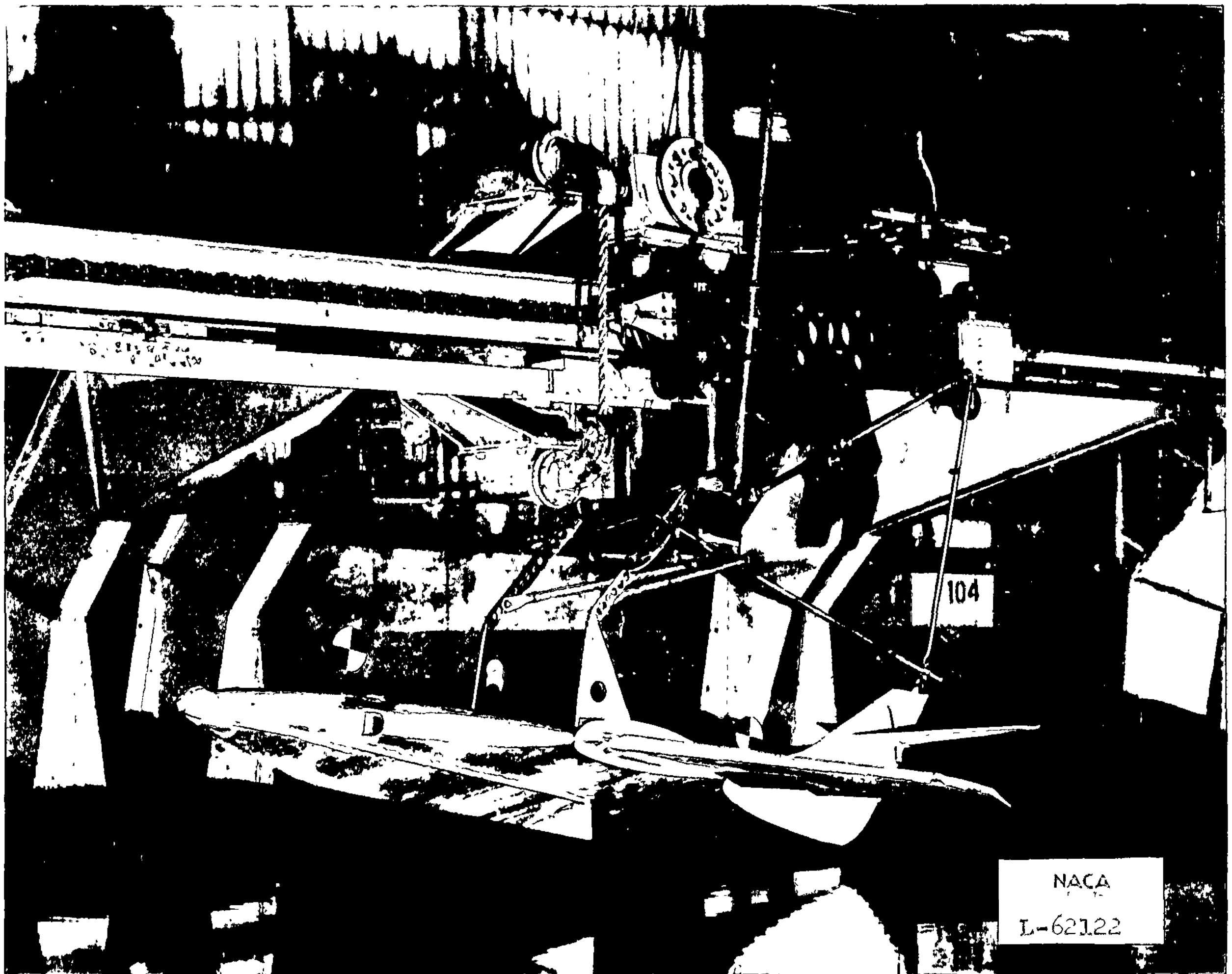

Figure 2.– Setup of model on monorail launching gear.

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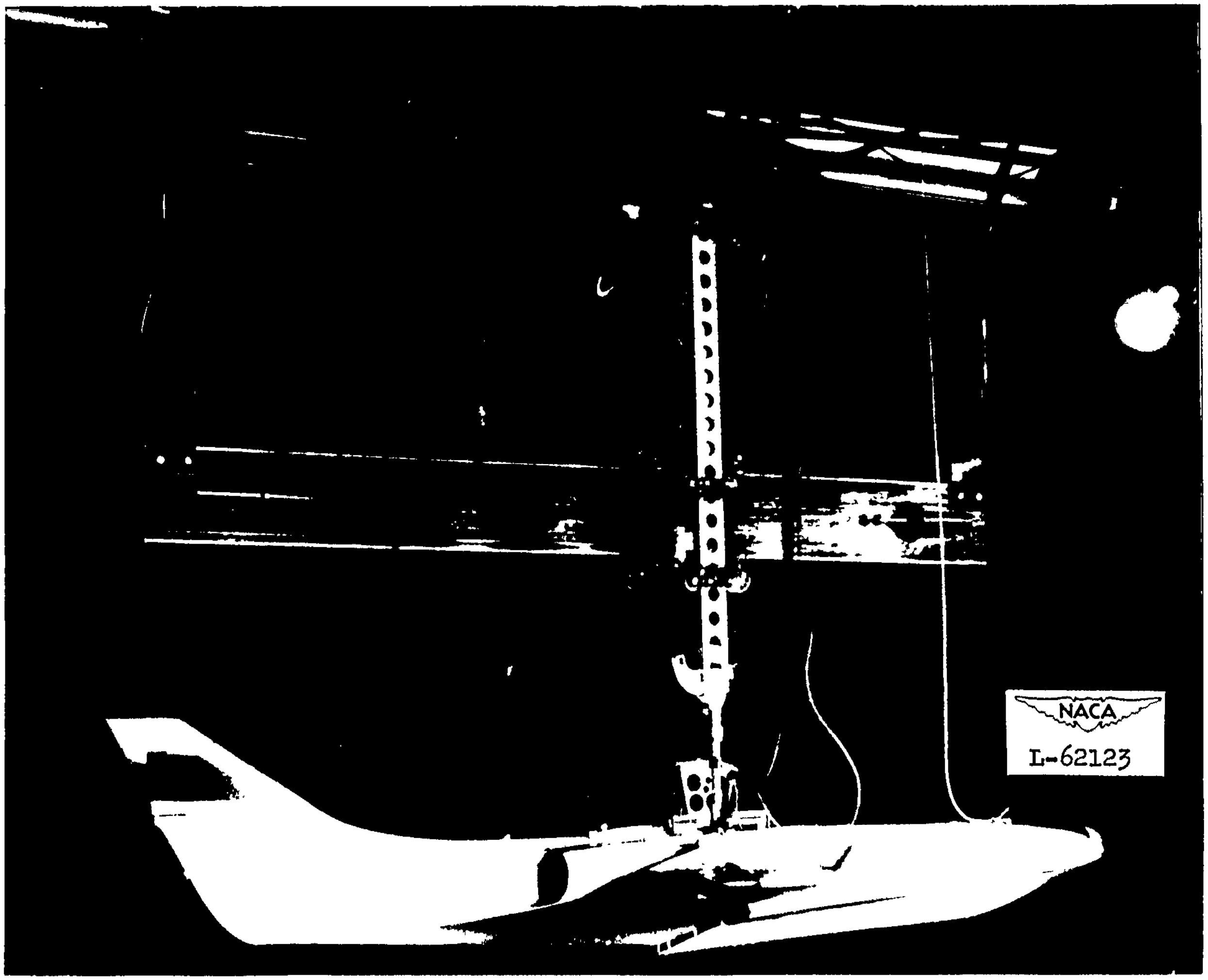

Figure 3.— Setup of model on fore-and-aft gear.

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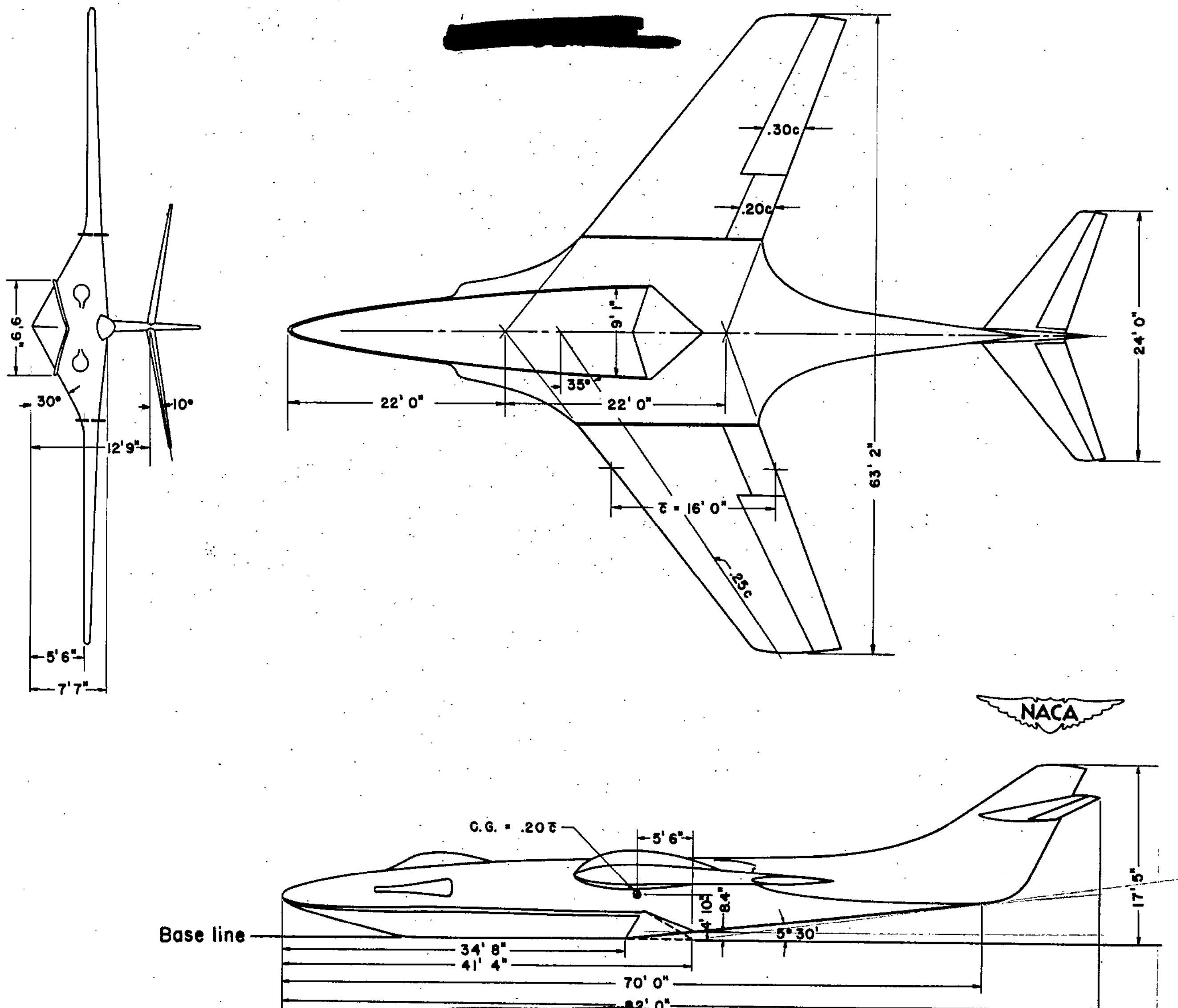

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Sternpost Angle = 7.5°

Figure 4.– General arrangement of Skate 7.

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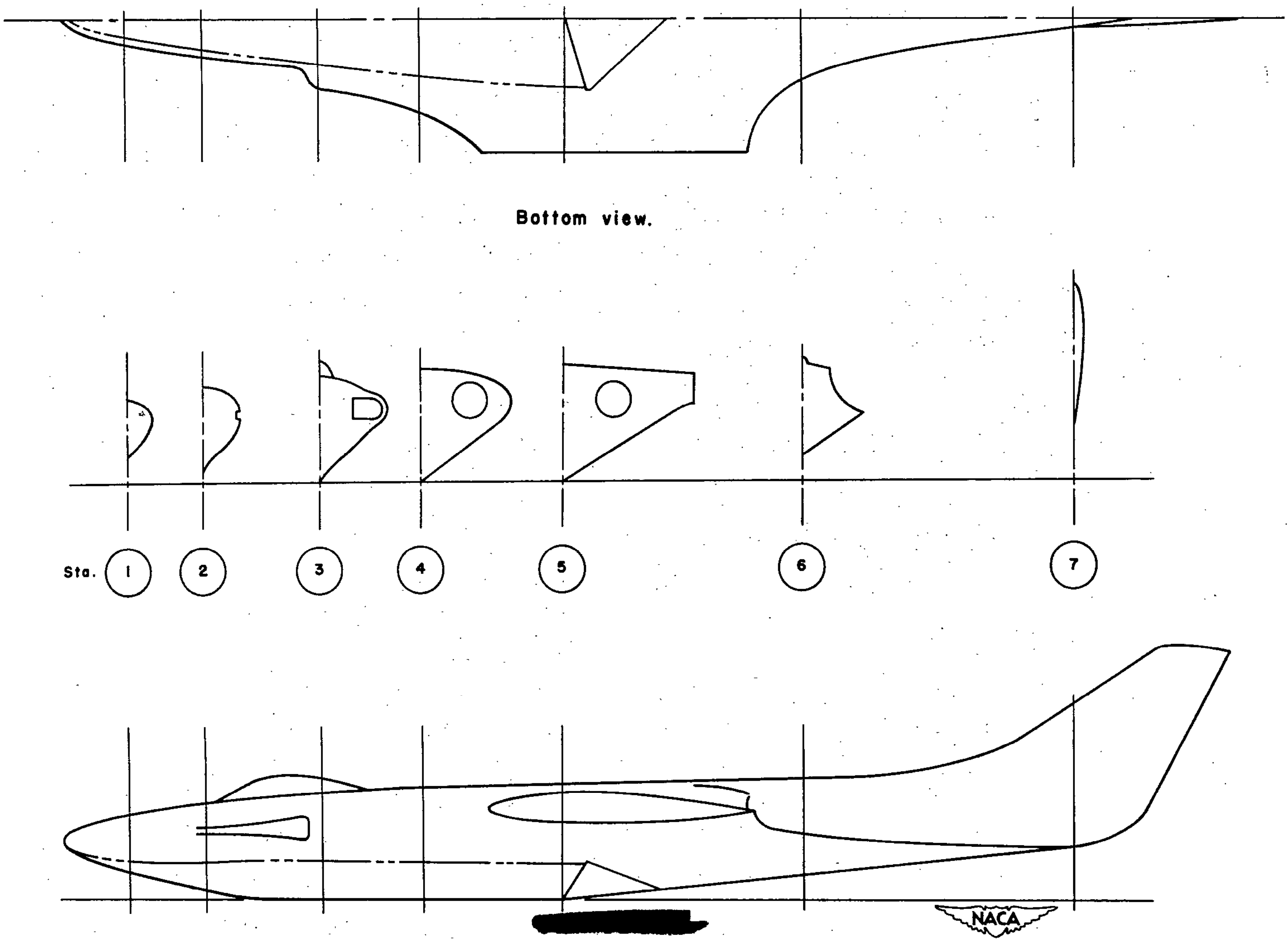

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Figure 5.— Hull lines of Skate 7.

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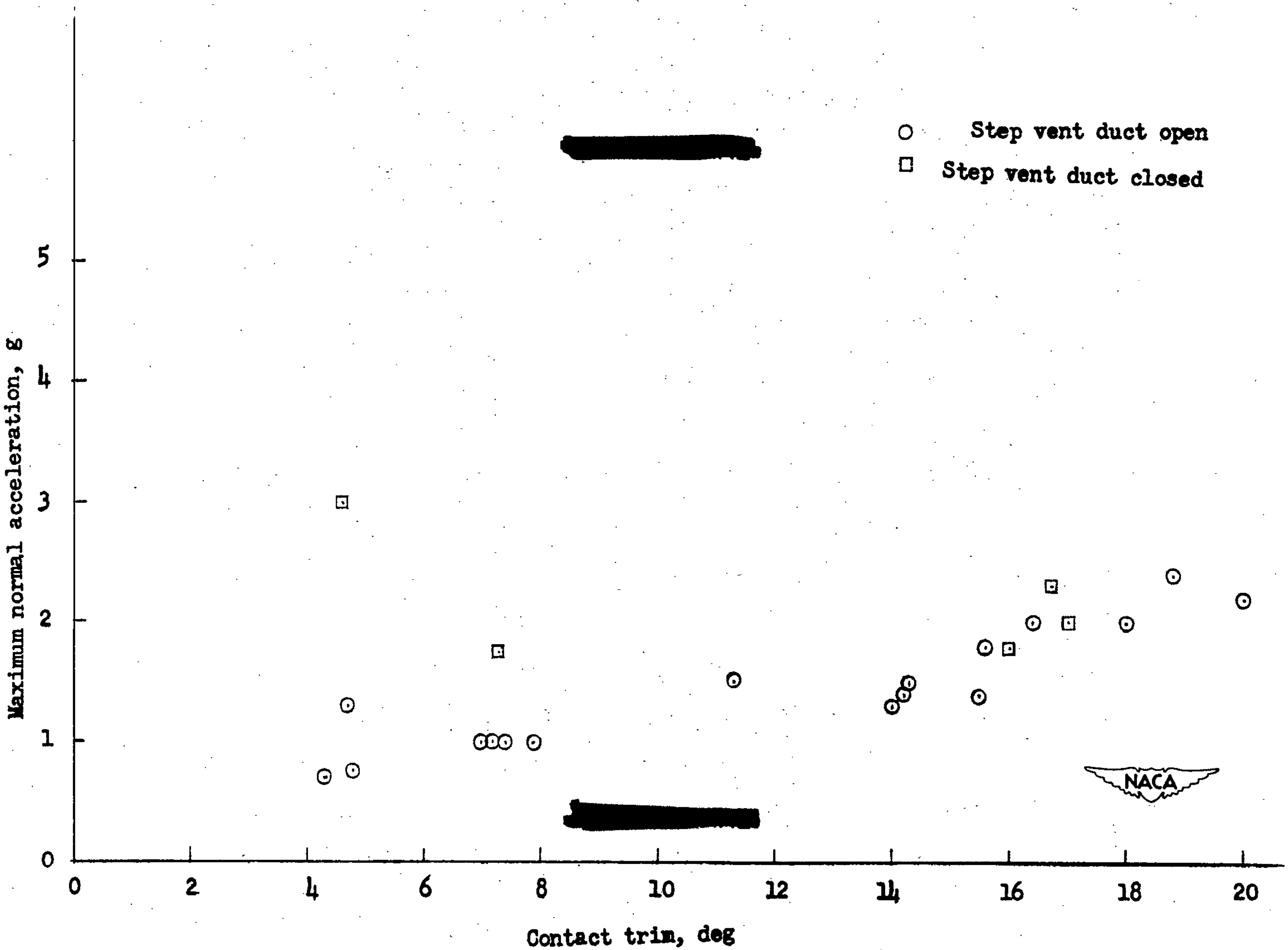

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Figure 6.– Maximum normal accelerations during smooth-water landings. Gross load, 33,370 pounds; flap deflection, 20°.

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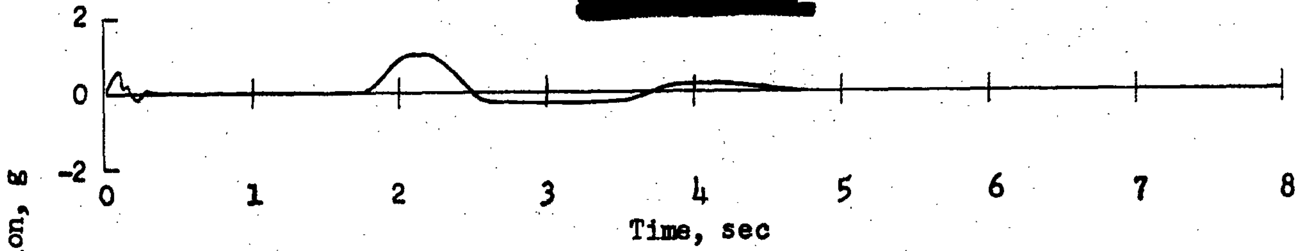
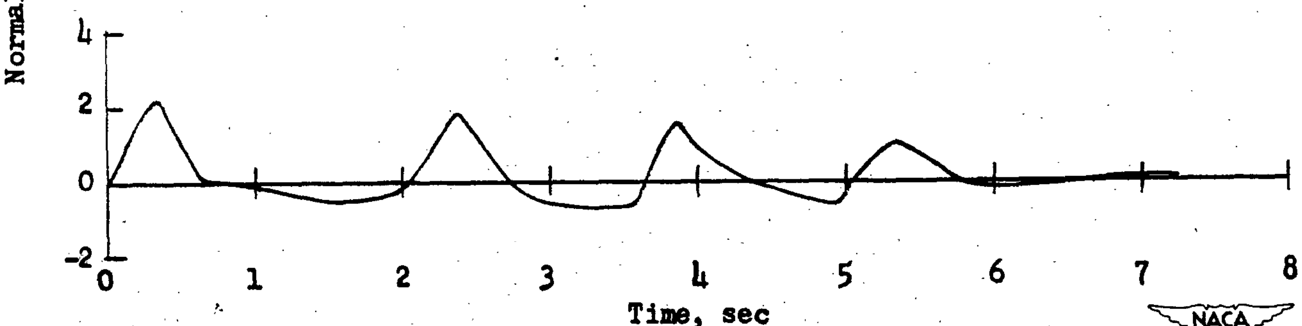


(a) Contact trim, 7.0°; landing speed, 93.7 knots.



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(b) Contact trim, 18.0°; landing speed, 83.5 knots.

Figure 7.- Normal accelerations during smooth-water landings. Gross load, 33,370 pounds; flap deflection, 20°.

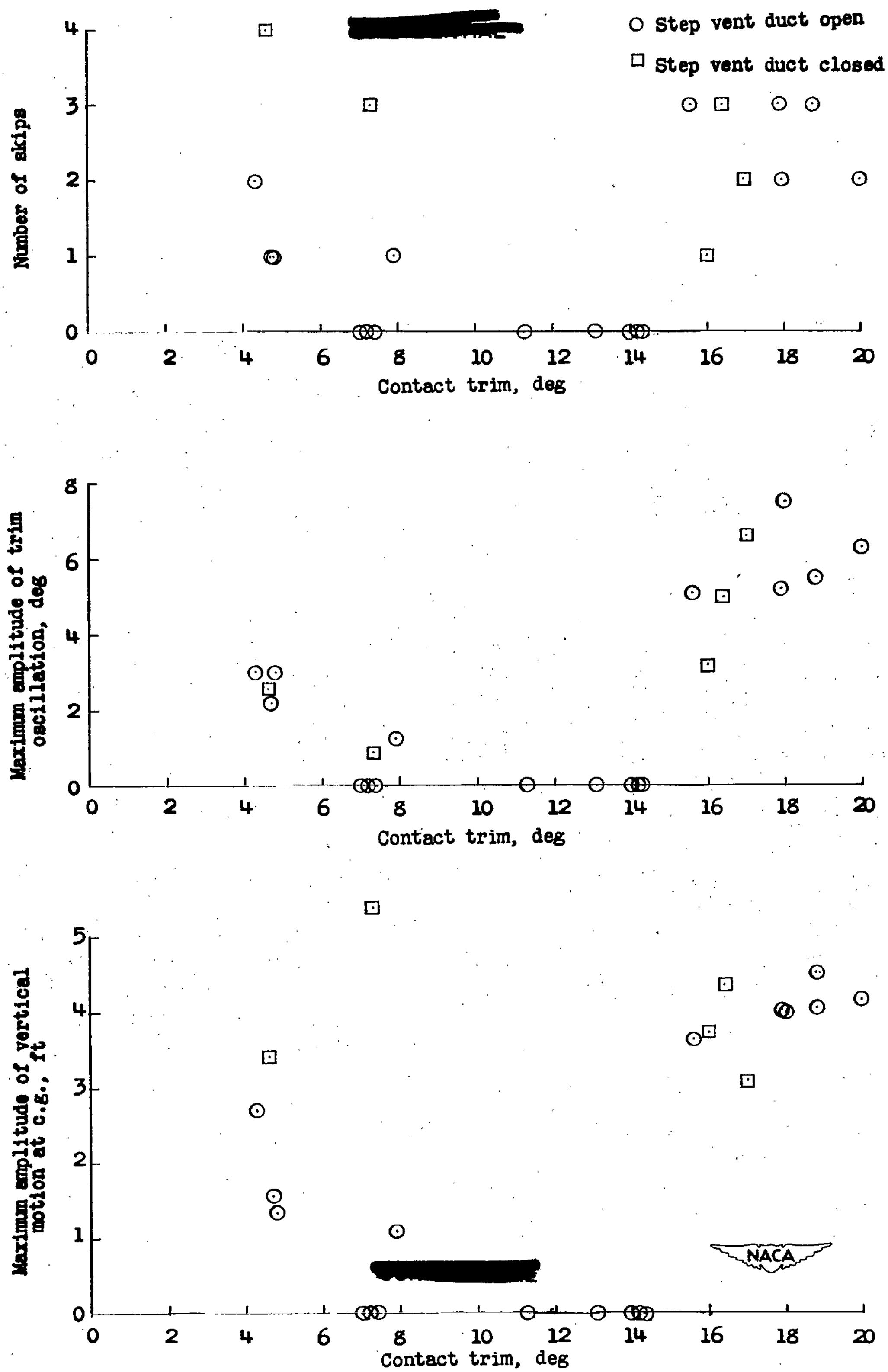

Figure 8.— Landing stability during smooth-water landings. Gross load, 33,370 pounds; flap deflection, 20°.

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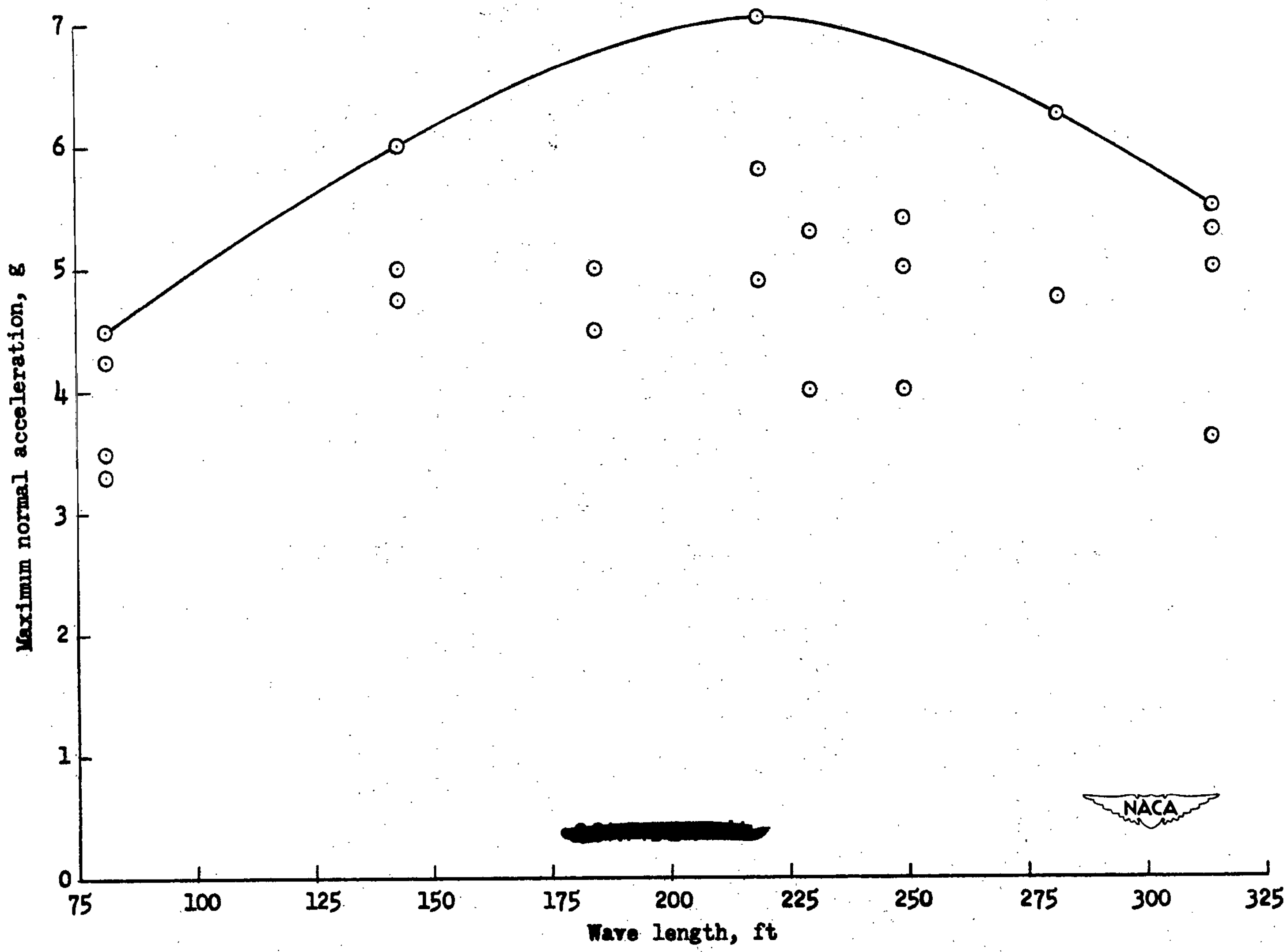

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Figure 9.- Maximum normal accelerations during landings in 4.5-foot waves at various lengths. Gross load, 33,370 pounds; flap deflection, 20°; landing trim, 8°; landing speed, 92 knots.

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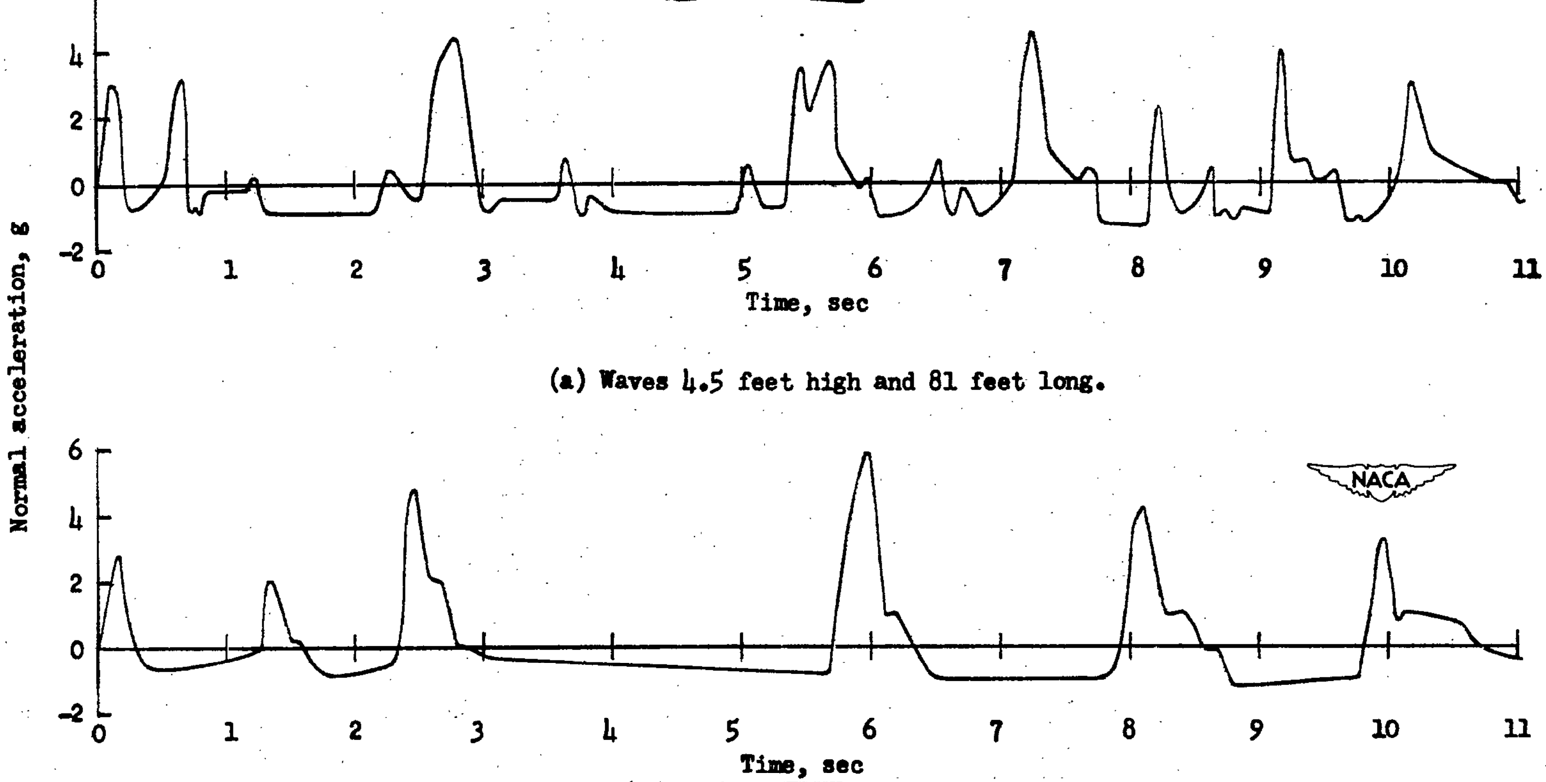

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(a) Waves 4.5 feet high and 81 feet long.

(b) Waves 4.5 feet high and 219 feet long.

Figure 10.– Normal accelerations during rough-water landings. Gross load, 33,370 pounds; flap deflection, 20°; landing trim, 8°; landing speed, 92 knots.

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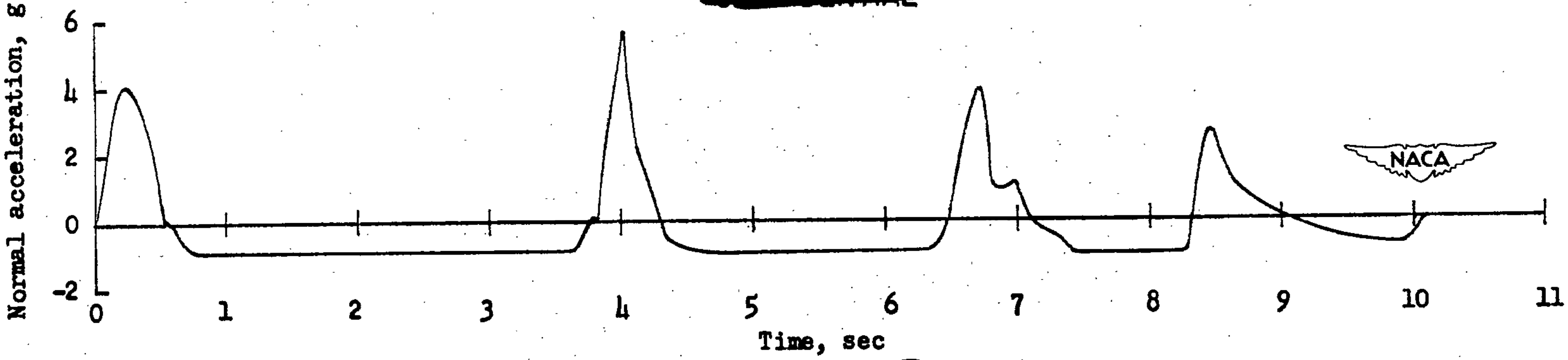

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(c) Waves 4.5 feet high and 315 feet long.

(c) Waves 4.5 feet high and 315 feet long.

Figure 10.– Concluded.

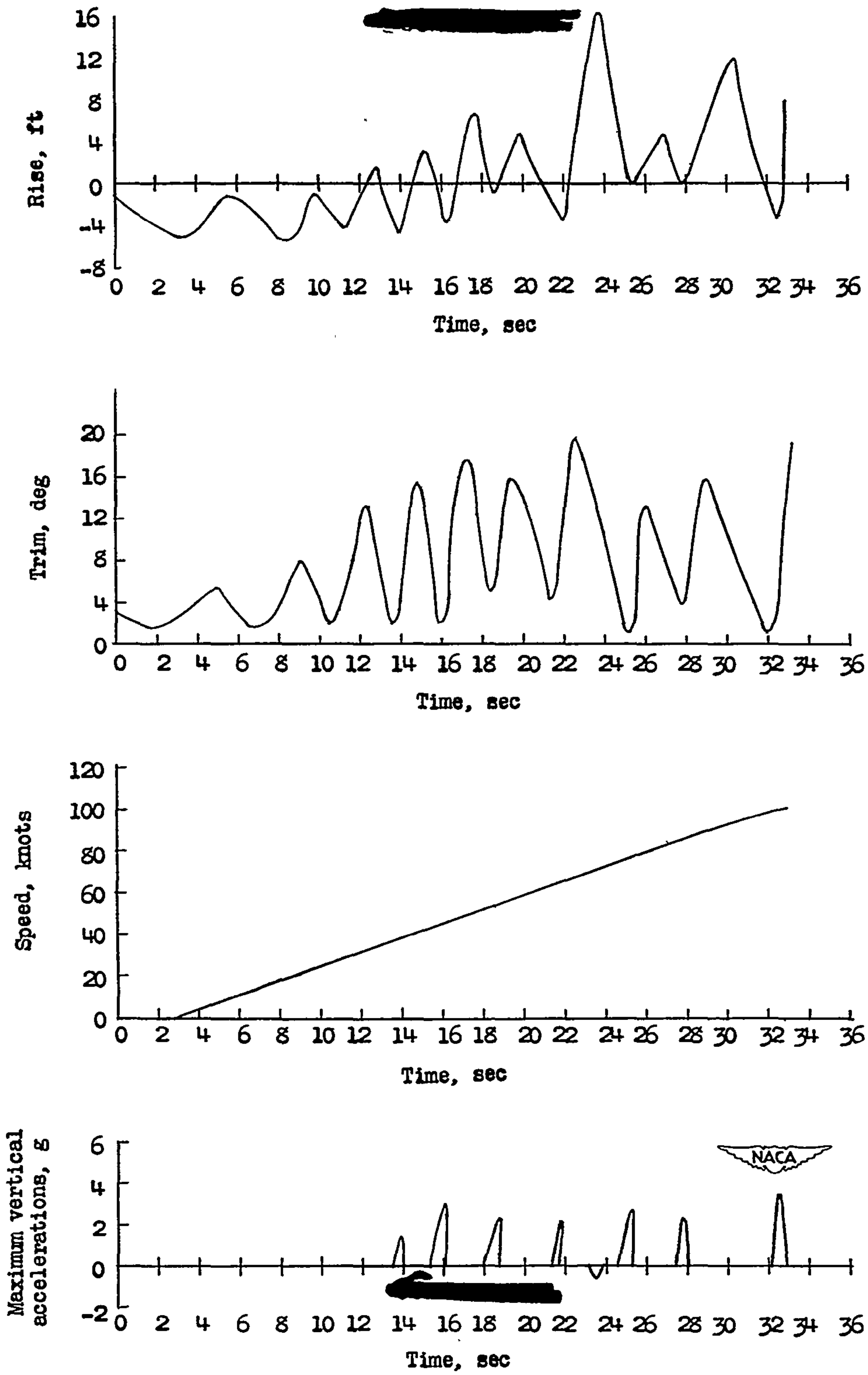

Figure 11.– Tracing of a typical oscillograph record made during take-offs in waves 4.5 feet high and 249 feet long. Gross load, 40,050 pounds; flap deflection, 20°; elevator deflection, –15°.